Ocean Color Level-3 Binned Data Products

1.0 Introduction

This document describes the specifications of Ocean Color Level-3 binned archive products which are produced and distributed by the NASA Goddard Space Flight Center's Ocean Color Data Processing System (OCDPS). The products are implemented in the Hierarchical Data Format (HDF), and HDF terminology is used in this document.

These specifications are given in terms of the logical implementation of the products in HDF and are not a physical description of file contents. Therefore, HDF software must be used to create or read these products.

Each Level-3 binned data product consists of the accumulated data for all Level-2 products, for the specified instrument and resolution, corresponding to a period of one day, 8 days, a calendar month, or a calendar year. The data are stored in a representation of a global, equal-area grid whose grid cells, or "bins," are approximately 81 km^2. See the *SeaWiFS Prelaunch Technical Report Series*, Volumes 27 and 32 for a discussion of the theoretical basis of the binning algorithm, a summary of the algorithm, the specification of the geographical and temporal specifications of the scheme, and the definition of a day with respect to data selected for daily binning--a "data day."

A pixel from a parent Level-2 product is excluded from binning if a bit in the parent Level-2 product's **l2_flags** corresponding to the pixel is set (equals 1) and the algorithm name for that bit has been specified to be used for exclusion by an input parameter to the binner.

The time binning step is used to combine bin products over progressively longer time scales. Time binning is used in turn to combine day bin products into 8-day and monthly products and monthly bin products into yearly products.

Each Level-3 binned data product will be stored in multiple HDF files. Each multi-file product includes a main file containing all product-level metadata and data for each bin that are common to all the binned geophysical parameters. In addition, each product includes 12 subordinate files (class = **DataSubordinate**), each of which contains data of one binned geophysical parameter for all bins. Subordinate files must be read in conjunction with the associated main file.

Note that the first 512 bytes (block) of each subordinate file contain an ASCII string equal to the global attribute **Product Name**. This physical block is not an HDF data object and the main file contains the pointers to skip this block when accessing the logical objects. Although not part of the specifications, the existence of this block is noted here since it can be useful to identify a subordinate file should its name be changed inadvertently.

2.0 Naming Convention

For a Level-3 binned data product, the form of the name of the main file is iyyyydddyyyyddd.L3b_ttt, where where i is the instrument identifier (S for SeaWiFS, A for MODIS/Aqua, O for OCTS), yyyydddyyyyddd are the concatenated digits for the GMT year and day of the year of the start and end days of the binning period, and ttt is a code for the binning period length. Binning period codes are DAY, 8D, MO, and YR. For daily products, only the year and day of the data are used; i.e., yyyyddd. Subordinate files have an extension xff appended to the name, where ff is a file number ranging from 00 to 11. Note that the "day of the year" for these products represents the dataday which may overlap calendar days to a small extent.

An example of a daily product's name is:

S1998001.L3b_DAY
S1998001.L3b_DAY.x00
S1998001.L3b_DAY.x01
.
.
.
S1998001.L3b_DAY.x11

Examples of product names for other binning periods are:

8-day:	S19980171996024.L3b_8D
	S19980171996024.L3b_8D.x00
	" "
	S19980171996024.L3b_8D.x11
month:	S19980321996060.L3b_MO
	S19980321996060.L3b_MO.x00
	" "
	S19980321996060.L3b_MO.x11
year:	S19980011996365.L3b_YR
	S19980011996365.L3b_YR.x00
	" "
	S19980011996365.L3b_YR.x11

8-day binning periods are continuous, starting from the first day of each calendar year.

Although it is not necessary to know the contents of the subordinate files in order to use them (HDF software will automatically access them as needed when using the main file), the files numbered 00 to 11 contain the _sum and _sum_sq fields (see below) of the following geophysical parameters, respectively: nLw_WWW (where WWW is one of the six visible band wavelengths), angstrom_WWW, chlor_a, K_490, chlor_a_K_490, eps_78, and tau_WWW. For MODIS products, there is also a file numbered 12, containing sea surface temperature (SST). The band-center wavelengths for each sensor are given in Table 1.

3.0 Global Attributes

For global attributes that have constant values specific to this product type, the actual value is given.

3.1 Mission and Documentation

This section lists attributes which are common to all sensors, followed by sensor-specific attributes.

3.1.1 Common Attributes

Product Name (character): the name of the product main file (without path).

Title (character): "sssss Level-3 Binned Data", where sssss = “SeaWiFS, “MODIS/Aqua”, or "OCTS".

Sensor Name (character): "SeaWiFS", “MODIS/Aqua”, or "OCTS".

Product Type (character): "day", "8-day", "month", or "year".

Replacement Flag (character): "ORIGINAL" if this is the first version of this product delivered to the DAAC; otherwise, it is set to the name of the product to be replaced (superseded) by the present product.

Processing Time (character): local time of generation of this product; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYYDDDHHMMSSFFF.

Software Name (character): "BIN"; name of the software used to create this product.

Software Version (character): version of the software used to create this product.

Processing Control (character): path and name of the file containing the control parameters. This information is stored in the product as part of its processing history.

Input Parameters (character): all input and processing control parameters used by the calling program to generate the product. Vertical bars or carriage return characters serve as parameter information delimiters. This information is stored in the product as part of its processing history.

Input Files (character): the names of the Level-3 (scene or time-binned data) products (main file names without paths, each separated by one comma) from which the current product was created. This information is stored in the product as part of its processing history.

L2 Flag Names (character): list of algorithm names (each separated by one comma) for the flag bits; same names and order as the values of the attributes **f01_name** to **f32_name** of the **l2_flags** SDS in parent Level-2 products.

3.1.2 SeaWiFS-Specific Attributes

Data Center (character): "NASA/GSFC SeaWiFS Data Processing Center".

Station Name (character): "Wallops Flight Facility".

Station Latitude (4-byte real): 37.9272.

Station Longitude (4-byte real): -75.4753.

Mission (character): "SeaStar SeaWiFS".

Mission Characteristics (character): "Nominal orbit: inclination = 98.2 (Sun-synchronous); node = 12 noon local (descending); eccentricity = <0.002; altitude = 705 km; ground speed = 6.75 km/sec".

Sensor (character): "Sea-viewing Wide Field-of-view Sensor (SeaWiFS)".

Sensor Characteristics (character): "Number of bands = 8; number of active bands = 8; wavelengths per band (nm) = 412, 443, 490, 510, 555, 670, 765, 865; bits per pixel = 10; instantaneous field-of-view = 1.5835 mrad; pixels per scan = 1285; scan rate = 6/sec; sample rate = 7710/sec".

Data Type (character): "GAC".

3.2 Data Time

Period Start Year (2-byte integer): year of start of binning period (cf. **Start Year**); used to interpret **time_rec** of Vdata **BinList** when **Product Type** = "8-day", "month", or "year".

Period Start Day (2-byte integer): GMT day-of-year of start of binning period (cf. **Start Day**); used to interpret **time_rec** of Vdata **BinList** when **Product Type** = "8-day", "month", or "year".

Period End Year (2-byte integer): year of end of binning period (cf. **End Year**); used to interpret **time_rec** of Vdata **BinList** when **Product Type** = "8-day", "month", or "year".

Period End Day (2-byte integer): GMT day-of-year of end of binning period (cf. **End Day**); used to interpret **time_rec** of Vdata **BinList** when **Product Type** = "8-day", "month", or "year".

Start Time (character): start GMT of earliest input product; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYYDDDHHMMSSFFF.

End Time (character): end GMT of latest input product; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYYDDDHHMMSSFFF.

Start Year (2-byte integer): GMT year of data start for earliest input product.

Start Day (2-byte integer): GMT day-of-year of data start for earliest input product.

Start Millisec (4-byte integer): GMT milliseconds-of-day of data start for earliest input product.

End Year (2-byte integer): GMT year of data end for latest input product.

End Day (2-byte integer): GMT day-of-year of data end for latest input product.

End Millisec (4-byte integer): GMT milliseconds-of-day of data end for latest input product.

Orbit (4-byte integer): number of the orbit crossing 180^{o} longitude closest to equator at the start of the binning period.

Start Orbit (4-byte integer): number of the first orbit that may contribute data to this product; used for interpreting **time_rec** of Vdata **BinList** when **Product Type** = "day". This is the first orbit considered for binning into this product and had at least part of its data collected within the binning period. **Start Orbit** must be =<**Orbit** and will normally be =**Orbit** minus 1 or 2.

End Orbit (4-byte integer): number of the last orbit that may contribute data to this product. This is the last orbit considered for binning into this product and had at least part of its data collected within the binning period. **Last Orbit** will be greater (normally, by 1 or 2) than or equal to the orbit that crosses 180^{o} longitude closest to equator at the end of the binning period.

3.3 Data Description

Latitude Units (character): "degrees North"; units used for all latitude values in this product.

Longitude Units (character): "degrees East"; units used for all longitude values in this product.

Northernmost Latitude (4-byte real): center latitude of northernmost data-containing bin.

Southernmost Latitude (4-byte real): center latitude of southernmost data-containing bin.

Westernmost Longitude (4-byte real): center longitude of westernmost data-containing bin.

Easternmost Longitude (4-byte real): center longitude of easternmost data-containing bin.

Data Bins (4-byte integer): number of bins stored in this product; i.e., the number of bins containing data.

Percent Data Bins (4-byte real): percent of bins in the grid that contain data.

Units (character): concatenated strings giving units for each geophysical parameter Vdata in this product.

4.0 Level-3 Binned Data in Main File

The Level-3 binned data product Vdatas listed in each subsection below belong to the Vgroup **Level-3 Binned Data** which is of class **PlanetaryGrid**. For SeaWiFS Level-3 binned data products, this Vgroup is spread over multiple HDF files: a main file and 12 subordinate files. The main file contains the global attributes described above as well as the Vdatas described in this subsection.

4.1 Vdata SEAGrid of Class Geometry

This Vdata contains information needed for description of the geographic binning scheme to HDF access software (see Refence &) and may not be useful to most users.

Vdata **SEAGrid** of class **Geometry** contains one record of the following fields.

registration (4-byte integer): 5; location of characteristic point within bin.

straddle (4-byte integer): 0 (no); does a latitudinal band straddle the equator?

bins (4-byte integer): number of equatorial bins.

radius (8-byte real): 6,378.137; Earth's radius in kilometers.

max_north (8-byte real): 90.0; northernmost latitude in grid.

max_south (8-byte real): -90.0; southernmost latitude in grid.

seam_lon (8-byte real): -180.0; longitude of westernmost edge of grid.

4.2 Vdata BinIndex of Class Index

Vdata **BinIndex** of class **Index** contains one record of the following fields for each of the latitudinal bin rows in the geographic binning scheme. This Vdata contains information needed for description of the geographic binning scheme to HDF access software and may not be useful to most users.

row_num (4-byte integer): index of row corresponding to each **BinIndex** record.

vsize (8-byte real): north-south extent (degrees latitude) of bins for each row.

hsize (8-byte real): east-west extent (degrees longitude) of bins for each row; ranges from 360/**bins** for the two equatorial rows to 120.0 for the two polar rows.

start_num (4-byte integer): bin number of first bin in the grid for each row (cf. **begin**); always the same set of values for the set of rows.

begin (4-byte integer): bin number of first data-containing bin for each row (cf. **start_num**).

extent (4-byte integer): number of bins actually stored (i.e., containing data) for each row.

max (4-byte integer): the maximum number of bins in the grid for each row; ranges from 3 for the two polar rows to **bins** for the two equatorial rows.

4.3 Vdata BinList of Class DataMain

Vdata **BinList** of class **DataMain** contains one record of the following fields for each bin in which at least one pixel was binned. Records for bins in which no pixels were binned (**nsamps** = 0) are excluded from the product.

bin_num (4-byte integer): the index number of the bin represented by this record and corresponding records in each of the Vdatas of class **DataSubordinate**.

nobs (2-byte integer): number of observations (pixels) binned in this bin.

nscenes (2-byte integer): number of scenes contributing data (at least one pixel) to this bin.

time_rec (2-byte integer): represents the time distribution of the data for this bin (not currently used).

weights (4-byte real): sum of the weights of the equivalent bins of the input products.

sel_cat (byte): selection category representing the selection criteria used for binning (not currently used).

flags_set (2-byte integer): 32 bits in four bytes corresponding to those of the parent Level-2 products' **l2_flags**; a bit is set (=1) if any pixel in that bin had the corresponding bit set in the **l2_flags** value.

5.0 Level-3 Binned Data in Subordinate Files

The Level-3 binned product Vdatas listed below belong to the Vgroup **Level-3 Binned Data** which is of class **PlanetaryGrid**. For standard Level-3 binned data products, this Vgroup is spread over multiple HDF files: a main file and 12 subordinate files. Each subordinate file consists of one Vdata of class **DataSubordinate** and each Vdata is named for the geophysical quantity being binned as follows:

nLw_WWW: normalized water-leaving radiance (mW cm^{-2} um^{-1} sr^{-1}) at WWW nm, where WWW is the band-center wavelength for one of the visible bands; in the standard products, this parameter is stored for each of the six visible bands in each sensor (see Table 1).

angstrom_WWW: angstrom coefficient, WWW to 865 nm (see table 1).

chlor_a: chlorophyll *a* concentration (mg m^{-3}).

K_490: diffuse attenuation coefficient (m^{-1}) at 490 nm.

chlor_a_K_490: integral chlorophyll (mg m^{-2}), calculated using the Level-2 values chlorophyll *a* divided by K(490).

eps_78: epsilon of aerosol correction at the two NIR wavelengths.

tau_WWW: aerosol optical thickness at WWW nm (see table 1)

SST: sea surface temperature (MODIS only).

Each Vdata contains two fields, the names of which are made up of the name of the Vdata itself concatenated with _**sum** and _**sum_sq**, as, for example, **nLw_412_sum** and **nLw_412_sum_sq**:

_**sum** (4-byte real): weighed sum of binned pixel values for corresponding geophysical parameter.

_**sum_sq** (4-byte real): weighted sum of squares of binned pixel values for corresponding geophysical parameter.

These fields are used to with the corresponding **weights** field to compute statistics for each parameter in each bin as follows:

The arithmetic mean is computed by dividing the parameter _**sum** value by **weights**.

The variance is computed by first dividing the parameter _**sum_sq** value by **weights**, and subtracting the square of the arithmetic mean.

This is described in more detail in SeaWiFS Prelaunch TM Vol. 32, Appendix C. The calculations described above are performed automatically by SeaDAS when Level-3 binned products are input for display.

Table 1. Band-center wavelengths by sensor (nm). These are used in the geophysical parameter names that are based on wavelength.

SeaWiFS	MODIS	OCTS
412 (1)	412 (1)	412 (1)
443 (1)	443 (1)	443 (1)
490 (1)	488 (1)	490 (1)
510 (1),(2)	531 (1),(2)	520 (1),(2)
555 (1)	551 (1)	565 (1)
670 (1)	667 (1)	670 (1)
765	748	765
865 (3)	869 (3)	865 (3)

(1) Used for **nLw_WWW**
(2) Used for **angstrom_WWW**
(3) Used for **tau_WWW**